REPORTS OF RESILIENT PERFORMANCE: INVESTIGATING OPERATORS' DESCRIPTIONS OF SAFETY-PRODUCING BEHAVIORS IN THE AVIATION SAFETY REPORTING SYSTEM

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While many existing taxonomies and frameworks provide a common vocabulary for describing how human operators fail in the context of sociotechnical systems, at present, there is no common vocabulary to describe how humans succeed. Such a framework would facilitate systematically collecting and analyzing data on how human performance can produce safety, not just how it can reduce safety. One potentially rich source of currently available information for exploring desired performance is the reports submitted to NASA's Aviation Safety Reporting System (ASRS). These de-identified, confidential, and voluntary narrative reports are submitted by pilots, controllers, ground operators, and others within aviation operations. While these reports are primarily submitted to describe safety risks, incidents, and problems, they also often describe how those risks were mitigated, and provide a window into aspects of everyday work in aviation. This paper describes an analysis of ASRS narratives to understand how operators talk about their own resilient behaviors during adverse safety conditions and events. Guided by Erik Hollnagel's Resilience Assessment Grid framework (i.e., anticipate, monitor, respond, learn), we illustrate our approach and methodology with examples from reports. We also highlight some of the challenges and how further research is needed in developing a taxonomy of operators' descriptions of resilient performance.

Safety has largely been viewed and defined by examination of threats, errors, and undesirable behaviors. Although most of the time things go right, there are no common methods to collect information from operations when they do, and there is no common vocabulary that exists to discuss these successful behaviors nor taxonomy to organize them. However, one potentially rich source of currently available information to learn about resilient performance is reports submitted to the ASRS. These de-identified, confidential, and voluntary narrative reports

are submitted by pilots, controllers, ground operators, and others within aviation operations. These reports present an opportunity to look at "small" (incidents not accidents) but frequent events in everyday work.

Operators submit reports to ASRS typically after something went wrong. Pilots' behaviors that result in successfully handling complex situations may often not be reported, as they are likely viewed as part of their job. Our premise is that nearly every ASRS report demonstrates resilient potential(s) and is an example of positive outcomes, since operators survived the event and were able to write the report. Terms such as "resilience" or being "resilient" are not currently part of the language of how operators talk about their own performance in ASRS reports, despite descriptions that clearly demonstrate resilience.

Resilience, described in a general way, is an adaptive capacity that contributes to successful outcomes. Looking at resilience can increase our understanding of how safety is produced and where to focus safety training efforts. Detecting resilient performance in these reports was guided by Erik Hollnagel's Resilience Assessment Grid framework (Hollnagel, 2015). Hollnagel identifies four potentials that are necessary for resilient performance. A system's resilience is described by its potential to: Anticipate (knowing what to expect, anticipating disruptions, new or changing situations), Monitor (knowing what to look for in one's performance as well as in the environment), Respond (knowing what to do, respond to changes and adjust), and Learn (knowing what happened, learning from the experience, and learning the right lessons). In ASRS reports, these potentials manifest themselves in behaviors. These descriptions of behaviors can be analyzed and identified (or labeled) as resilience potentials.

Method

The ASRS database can be searched in a variety of ways. The database is vast, with currently over a million and a half reports in its repository, and growing by the hundreds on a daily basis. Searches can result in thousands of reports to review which can be labor intensive and time consuming. Descriptions of resilient performance can also include more than key words and phrases. Key word searches can be informative, but can fail to detect resilient behaviors that are not specifically named. Refined investigations can include using combinations of selected keywords, phrases, filters, codes (e.g., ASRS coding taxonomy), and/or focusing on specific targeted situations or events (e.g., Chandra et al., 2020). With the quantity of data contained in narratives, software tools may facilitate and enhance searches and analysis. For example, some software programs can be utilized as discovery tools (e.g., based upon frequency of terms in documents) or as query tools (e.g., based upon searching for similar documents that have a shared context). Ongoing research efforts continue to explore the possibilities and limitations of various tools for analyzing data from ASRS reports. Using such tools for ASRS data analysis has been conducted (Paradis, et al., 2021) but further investigations are necessary.

Using Hollnagel's framework, Holbrook et al. (2019) identified resilient performance strategies, employed in routine aviation contexts, as a way to organize identified behaviors, for each of the four potentials. For example, for the Learn potential, Holbrook et al. identifed four strategies: 1) Leverage experience and learning to modify or deviate from plan., 2) Understand formal expectations., 3) Facilitate others' learning., and 4) Conduct after-action debriefing.

These strategies can be used to identify and code operators' statements. To illustrate our approach and to address some of its challenges, specific statements from selected reports are used as examples below, with accompanying notations and explanations. Examples #1-4 come from ASRS report #1516535.

Example #1

"*Assigned CHSLY3 RNAV Star into CLT, FO was PF, I was PM... FO had checked ATIS and noted that Runway 23 was in use. He also mentioned at that time that since Runway 23 is on the ATIS we would most likely get that runway from our direction. So FMC was planned with Runway 23 during cruise…*"

Based on the proposed coding scheme, the First Officer (FO) is both Anticipating and Learning through conducting a pre-action briefing, leveraging his experience, and facilitating others' learning (FO to Captain [CA]). He discusses the planned action and identifies the variable that affects the plan. The CA describes how the FO anticipated what to expect, and compared his experience to the current situation to develop real-time assessment and to modify the plan. Since neither crew member used the word Anticipate or Learn in the narrative, this report would not be returned using those resilient terms in a keyword search (although a search using the keyword "Respond" would return this report, because it appears later in the narrative). Another issue is that the action of the FO can be identified as both Anticipate and Learn. The coding scheme does not account for strategies that fit into more than one potential. One strategy may be described by both potentials, or even be associated with or linked to another potential (e.g, Learning leads to Anticipating). Hollnagel describes this as "the interdependence of the potentials". Similarly, Kiernan et al. (2020) describes these enablers of resilient performance as "exhaustive but not mutually exclusive". The same words can represent different strategies depending on context, and different words can represent the same strategy. This makes such coding challenging, particularly when developing a taxonomy to group data in a meaningful and systematic way.

Example #2

"At about that time the FO asked what should I do? I said start slowing."

In this situation, the Learning opportunity occurs between the FO and the CA. The CA is facilitating the FO's learning. This strategy is described as, "sharing information with others to increase their immediate understanding and long-term learning" (Holbrook et al., 2019). Individuals bring with them their past experience and knowledge, which affects their actions, so determining the source of the Learning may require further investigation in this work. This is evident in the next example.

Example #3

"I have found out the hard way that this aircraft will not come down and slow down simultaneously. Phone call with OPD guy was enlightening as he says this is a huge ongoing issue..."

Though he doesn't go into detail about "the hard way", the CA is describing his Learning through experience, and his Learning is further facilitated through his conversation with a colleague.

Example #4

"Approach saw our problem and said nicely, I'm going to spin you around and get you back on a heading to intercept localizer for 23."

The opportunity to Anticipate, Monitor, and Respond is attributed to the Approach air traffic controller (ATC). ATC anticipates and notices the problem, and adjusts the current plan. ATC monitored the crew's ability to make the descent, with cues signaling a change from normal or expected operations. This statement depicts the role of ATC and describes how different actors contribute to resilience in the system. Another method of evaluating resilience in ASRS reports can focus the analysis on the turning points and triggers of an event. In this situation, it was ATC that changed the course of the flight.

Example #5 (ASRS #1741671)

"…I called for a Go Around… the Go Around was done to look at a problem…Captain decided to keep Flaps 1 .. to avoid a potential emergency gear extension procedure…Crew Established and Communicated a plan that entailed to [advise] with ATC to have CFR in place and RWY priority in [if] *necessary. We communicated our intentions with flight attendants and advised passengers and Dispatch. We requested delay vectors to run the required QRH Decent Checklist…We followed the QRH procedures, and [advised ATC], requested fire rescue to be ready…Captain..decided to stop on runway to have CFR look over outside of aircraft… I decided that taxi was too difficult…and requested a tow…Crew debriefed for clarification, any issues and ways procedure/crew actions could be improved.*

An FO complied with a CA's call for a go-around while handling a loss of hydraulic fluid. The Captain was Monitoring and Responding to a rapidly changing situation, and called for a go-around. The operators describe several strategies during and after the incident that indicate resilient performance. They also include some explanations of their understanding, communication process, assumptions, and motivations. Narrative self-reports can provide this kind of information.

Actions are often judged based on the subsequent outcome. However, the decision to call for a go-around may be appropriate in one situation, but not in the next. Had the outcome been poor, a go-around would not be considered "desired" performance, but the capabilities to anticipate the need, monitor for relevant cues, and adjust the flight by executing a go-around all contribute to the potential for resilient performance. Furthermore, some operators are very explicit in describing what they were Anticipating, or were Monitoring for, etc., but other times these descriptions are implicit. Thus, reading for a deeper understanding of the meaning in context and the subtle nuances can increase insight.

Example #6 (ASRS #1759282)

[Leg 1] *"I read the clearance back and wrote down "HFR" at the bottom of my clearance…"*

[Leg 2] *"I put the checklist between the throttles to remind me and verbally repeated "Hold for Release" on every radio call on CTAF frequency."*

By leveraging his experience and managing available resources, pilot Learning and Responding occurred between two flight legs in this narrative. The flight crew received a Hold for Release (HFR) due to a maintenance delay, so the pilot wrote this down as a reminder. Bag loading was completed, and the flight crew started the engines, taxied, and took off. However, they took off without receiving ATC clearance. The pilot recognized the risk of forgetting the clearance from the first leg and so, to prevent this from happening again on the next leg where they again receive an HFR, devised additional memory cues by putting the checklist between the throttles, and by repeating the phrase to keep the information active in working memory. These reports can provide Learning opportunities for both individuals and organizations. The examples above provide an opportunity to learn how operators describe their own resilient performance, and illustrate the complexity of labeling and coding these behaviors.

Discussion

There is no common vocabulary to describe how humans succeed, and a method to systematically capture success does not yet exist. Taxonomies can be created in many different ways and for many different purposes (e.g., Operator's Guide to Human Factors in Aviation, 2010; International Civil Aviation Organization Accident/Incident Data Reporting System Taxonomy, 2013). Our analysis highlights the challenges in determining how to capture and group expressions of resilient performance meaningfully into a taxonomy that could be useful for both machine analysis of the data and support human analysis.

In creating a framework that increases understanding and where to focus safety training efforts, it may be helpful to determine both who and what it was that created the opportunity for resilience or directly contributed to resilient performance: Was it an individual, a flight crew team, or a procedure created by the organization? And what did it or they do to contribute to resilience? This may help in learning what kind of support is needed to promote resilient performance as operators do their jobs and within the organization. It is worth considering Vesel's (2020) descriptions of the challenges and biases present in attributing causality in an event, particularly in written investigation reports. Vesel addresses the biases, linguistic framing and shortcuts that occur which can hinder safety promoting efforts. Attempting to "fit human action into preset, limited categories," such as in a taxonomy is an example. Vesel proposes ways to increase the opportunities for learning by looking at the context of an event and the interrelations between factors.

Conclusion

Operators describe their resilient performance in ASRS reports in many ways. Operators' narratives provide descriptions of resilient performance, even for reports intended to describe something that went wrong. In the above examples, the resilient potentials of Anticipate,

Monitor, Respond, and Learn are present in operators' descriptions. Hollnagel's framework created opportunities for identifying resilient performance, yet presented new challenges. Machine learning (ML) and natural language processing (NLP) applications may also be helpful in the analysis of large datasets, but the assumptions and implications of using search and query tools for the ASRS database must be understood. An interesting avenue currently being explored is "sentiment analysis." It utilizes NLP techniques to detect emotions and tones in written text, which may be useful in helping to identify expressions of positive, resilient human behaviors. Addressing the present challenges in future research can enable further learning from operators' safety producing behaviors and resilient performance.

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